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Predictive Outcomes of Revision Total Hip Replacement – A consecutive series of 1176 patients with a minimum 10-year follow-up

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Abstract

The burden of revision total hip replacement (THR) surgery is increasing. With an increasing life expectancy and younger age of primary surgery this trend is set to continue. There is little data on the long-term outcome of revision THR. This retrospective study of 1,176 consecutive revision THRs with a minimum 10-year follow-up from a University Teaching Hospital was undertaken to review implant survival and patient reported outcomes.

Mean follow-up was 11 years with implant survival at 10 years of 82% (CI: 80 – 85). Implant survival varied between 58% (unexplained pain) to 84% (aseptic loosening) depending on the indication for revision surgery. Positive predictors of survival were age greater than 70 at the time of surgery ($p=0.011$), revision for aseptic loosening ($p<0.01$) and revision of both components or just the acetabular component ($p<0.01$). At the last review, mean Oxford Hip Score (OHS) was 34 (SD: 11.3) and 92% of the living patients with unrevised hips were satisfied with the outcome of revision surgery.

This long term study has demonstrated that positive predictors of survival and outcome of revision THR surgery are age greater than 70 years, revision for aseptic loosening and component revision. This should aid surgeons in their counselling of patients prior to surgery.

Keywords: Revision Total Hip Replacement, Survival, Outcome predictors, 10-year follow-up

1. Introduction

The introduction of a well functioning primary Total Hip Replacement (THR) by Charnley in 1962 has led to THR today providing excellent clinical outcomes and survival for those with a variety of hip pathologies [1,2]. Furthermore, multiple series are available which allow clinicians to give predictions of outcome with different implants [3-5]. However, the constant growth in the number of THRs performed every year, the increasing number of primary surgeries being performed at a younger age and increased life expectancy have contributed to a significant increase in the revision burden [6, 7].

Survivorship of revision hip surgery has been well documented but is usually in the form of small single surgeon series. We are aware of only two published series with greater than 1000 cases that quote 10-year survival, (72% to 82%) [8,9].

Patient Reported Outcome Measures (PROMs) are increasingly being used to document implant success, as well as being used as a tool to define treatment options [11]. Evidence to support predicting functional outcome post revision is limited and, when available, the data usually reflect small numbers and short follow-up [12,13].

The aim of this retrospective observational study was to assess patients with a minimum of 10 year follow-up who had a revision THR performed at a single tertiary referral unit (University Teaching Hospital) to assess what factors, if any, were the predictors of survival, function and patient satisfaction.

2. Materials and Methods

Theatre logbooks between 1996 and 2002 at the Nuffield Orthopaedic Centre, Oxford, UK were retrieved. All revision THRs were identified and the operative notes examined to obtain relevant data in a standardised fashion. Cases were excluded if the primary procedure was not a THR or if the revision procedure was not the first revision surgery on that joint, (thus cases of conversion of hemiarthroplasty and hip resurfacing, Girdlestone procedures and re-revision were excluded).

The revisions were further defined according to the components revised. Revisions involving exchange of the cup and stem were classified as revisions of “both components.” Acetabular cup revision was classified as “cup only”, stem alone revision was classified as “stem only”, head and/or liner exchange as “isolated head/liner” revision and those requiring a two-stage revision of both components as “two-stage revision”.

Following the identification of appropriate patients, the components revised and indications for revision surgery were obtained from medical notes and clinic letters. Component loosening, with or without instability, was defined as “aseptic loosening” with revision for dislocation or subluxation classified as “instability”. Revision for fracture in the absence of infection was classified as “peri-prosthetic fracture” and other diagnoses for revision, for example prosthesis fracture, heterotopic ossification and leg length discrepancy, were classified as “other”. Pain in the absence of any of the previously mentioned causes was defined as “unexplained pain”. In the cases of revision for suspected infection, the clinical suspicion was confirmed by histological

and microbiological investigation with the infecting organism identified where possible. Isolation of the same organism(s) in more than three separate samples and/or the presence of more than five white blood cells per high power microscopy field in any of the histology samples were considered diagnostic of infection [14,15]. If the patient presented with a sinus tract, the case was considered to be infected even in the absence of positive microbiology or histology [16]. These cases formed the “infected group”.

Local ethics committee confirmed that no formal approval was necessary for this study. All patients were contacted to assess their functional outcome with the Oxford Hip Score (OHS) [17,18] and a study specific questionnaire. If one or two OHS questions were unanswered, a mean value representing all other responses was calculated and used for missing values [17]. OHS questionnaires with three or more missing responses were deemed invalid [17]. Patient reported satisfaction was defined using a nominal scale (1: Very displeased, 2: Not very pleased, 3: Fairly pleased, 4: Very pleased). Patients who responded as either “very displeased” or “not very pleased” were classified as “unsatisfied”, with the remaining responses deemed to be “satisfied”.

All patient responses were compared with all hospital documentation to check for discrepancies and, in the case of deceased patients, for implant failure. Non-responders were sent follow-up letters and, in the case of those who did not reply, their General Practitioner was contacted. All patients who were either lost to follow-up or who had died were utilised in the analysis and were censored at either the time of death or when their last documented review.

2.1 Statistical Analysis

Statistical analysis of the data was carried out using SPSS for Windows v 18.0 (SPSS Inc., Chicago, Illinois). Covariates tested were: gender, patient age at revision, the revision undertaken, the indication for revision and the method of fixation. Patients were divided into two age groups: those under 70 years at the time of surgery formed the “young” group, with the remaining patients defined as being in the “old” group.

Survival data were obtained by Kaplan-Meier analysis [19]. Survival was calculated with a failure defined as any operation in which a component was exchanged or removed. Significant differences in survivorship were established using Log-rank tests and significant variables were then analysed using a multivariate Cox model, taking into account interaction terms, in order to estimate the true magnitude of influence of each covariate on implant survivorship.

The Mann Whitney-U test assessed the influence of each covariate upon patient reported outcome. A significance level of $p < 0.05$ was used throughout.

3. Results

A total of 1,336 hip revision procedures were identified of which 1,176 cases were the first revision of a THR. 1,054 (90%) were performed by five orthopaedic surgeons with a specialist interest in arthroplasty surgery. Of these 1,109 patients, 67 had bilateral revisions. The mean age at surgery was 68 years, (range: 23 to 97 years) and mean follow up was 11 years (range 2 to 14 years). 632 patients were female and 26 patients were lost to follow up. Functional questionnaires were returned in 79% of living patients.

Both components were revised in 576 hips (49%); the acetabular cup alone was revised in 306 cases (26%); the stem only in 188 cases (16%). A two-stage revision was performed in 94 cases (8%) and there was an isolated head/liner exchange in 12 cases (1%). In total, 14 different types of acetabular cup and 12 different stems were implanted. All revised stems were cemented with 278 of the revised acetabular cups being uncemented,

Revision was performed for aseptic loosening in 843 cases (72%), infection in 111 cases (9%), periprosthetic fracture in 92 cases (8%), instability in 64 cases (5%), “unexplained pain” in 19 cases (2%) and for “other” reasons in 47 cases (4%).

Of the 111 cases revised for infection, 66 cases had a two-stage revision. 16 patients, (16 cases), were not deemed to be fit enough for a two-stage procedure and so had a single-stage revision. Additionally, a further 29 hips who had a single-stage revision were retrospectively identified through microbiological or histological findings as having an underlying infection and so were also included in the “infected” group.

3.1 Survival

The 10-year survivorship of all-cause revision was 82% (95% CI: 80 to 85) (figure 1). At mean follow-up of 11 years, 440 hips were deceased of which 56 had been re-revised prior to death. Of the 772 living cases, 148 were re-revised prior to follow-up and 27 hips were lost to follow-up (2.3%).

Gender had no influence on survival with 10-year survivorship 83% (95% CI:80-87) in men and 82% (95% CI: 78-85) in women (log-rank, $p=0.80$) (table 1). Implant survivorship at 10 years in the Old group, (patients older than 70 years at revision surgery), was 89% (95% CI: 86-92) and significantly better (log-rank, $p=0.01$) than that of the Young group (79%, 95% CI: 75-82). Furthermore the survivorship in those under 60 years was 74% at 10 years and 85% in those over 60 (log-rank $p=0.01$).

10-year survivorship when both components were revised (84%, 95% CI: 80-87) and when the cup only was revised (86%, 95% CI: 82 - 90) was significantly better (log-rank $p=0.01$) than when the stem only was revised (77%, 95% CI: 70-84). Isolated head/liner exchange and two-stage revision had survivorship at 10 years of 60% (95% CI: 32-87) and 76% (95% CI: 67-86) respectively (figure 2). There was no significant difference (log-rank = 0.37) when comparing cemented hip survival, (where both components were cemented, 84%), versus hybrid survival at 10 years which was 81% (and where the acetabular component was uncemented).

Revision for aseptic loosening had a significantly (log-rank, $p<0.01$) better 10-year survival (84%, 95% CI: 82-87) than revision for infection (78% 95% CI: 69-86), instability (78% 95% CI: 66-90), periprosthetic fracture (73% 95% CI: 62-85) and unexplained pain (58% 95% CI: 32-83) (figure 3).

Sub-group analysis revealed that revision for aseptic loosening had the best 10-year survival if revision was “both components or cup only” compared to “stem only” (85% v 77%, log-rank $p=0.03$). Similarly, those cases revised for instability had significantly better 10-year survival (log-rank, $p<0.01$) if the procedure was an

exchange of “both components, cup only or stem only” (84%) compared with those who underwent a “head/liner change” (47%). However, the numbers in the latter group were low, (10 cases), compared with the 52 cases in the other group.

Subgroup analysis of the “infected” group did not show any significant difference (log rank $p=0.57$) between the implant survival for one-stage revision (81% at 10 years) when compared with two-stage revision (76% at 10 years).

Multivariate Cox regression analysis revealed the age category, type of procedure and revision indication significantly influenced ($p=0.011$, $p=0.014$, $p=0.041$) revision implant survival although gender did not ($p=0.75$).

3.2 Oxford Hip Score

Mean OHS at follow-up was 34 (SD: 11.3, range: 3 - 48) (figure 4). Gender, age category, method of fixation or indication had no significant influence on OHS at 10 years post revision THR. However, there was a trend for a higher OHS in younger patients, male patients and those revised as a “single-stage” procedure.

In patients where there was a revision of “both” components and “cup only” revisions there were significantly, ($p=0.003$), higher OHSs compared to patients’ whose “stem only” was revised (mean: 34, SD: 10.9 Vs mean: 30, SD: 11.6 respectively). Although not significant ($p=0.55$), revisions where there was an isolated liner/head change (mean: 31, SD: 9.2) or where a two-stage procedure occurred (mean 32, SD: 12.9) had poorer OHS than other groups (figure 5).

The indication for revision did not significantly influence outcome. The mean OHS for patients revised for “aseptic loosening” was 34 (SD: 11.2), unexplained pain was 34 (SD: 6.2) and “other” was 35 (SD: 11.2) which was higher than those revised for infection, instability and periprosthetic fracture (means: 32, 33, 31; SD: 12.3, 12.2, 11.7 respectively)

The mean OHS for one stage revision was 32 (SD: 8.8, Range: 15 - 46), which compared to a mean OHS of 32 (SD: 11.7 Range: 5 - 48) for those undergoing a two-stage revision for infection. This was not significant (Mann-Whitney U, $p=0.71$).

If end-point for survival included OHS of <20 and revision, survival dropped to 77%.

3.3 Patient Satisfaction

92% of patients were satisfied with their revision operation (Table 2). Gender, age category, procedure, fixation method, and indication had no significant influence on patient reported satisfaction. There was however a trend towards higher satisfaction for “aseptic loosening” (92%) compared to revision for infection (85%) and periprosthetic fracture (84%). It was noted that those revised for instability and unexplained pain reported 100% satisfaction at follow-up, (although this was not statistically significant).

Additionally, two-stage revisions and procedures where there was an isolated head/liner exchange had low satisfactions of 82% and 80% respectively. This compared with higher satisfaction rates (93%) post revision of “both components”, “cup only” revision and one stage revision.

Patient reported satisfaction was strongly correlated with functional outcome with a correlation coefficient of 0.534 ($p<0.001$).

4. Discussion

This long-term study of outcomes and survival following revision THR has shown that generally the outcome of revision THR is good and four out of five patients will not need a re-revision at least for 10 years. It provides further evidence that patient age and revision for aseptic loosening are positive predictors of survival in primary revision hip surgery. This information is useful for patient counselling, especially the young patients who are about to undergo primary THR.

This is the first long term study to demonstrate a correlation between a PROMs and method of revision, as well as, overall patient satisfaction. Those revised for unexplained pain tend to have a worse outcome in terms of implant survival although in those not needing re-revision, the rate of satisfaction is highest.

A survivorship of 82% at 10-years is comparable to other reported literature outcomes [9] but remains poorer when compared to primary THR [1,2]. This study has longer follow-up, (mean 11 years), when compared with similar large sample studies [9,10].

Primary revision for “aseptic loosening” had a significantly (log-rank, $p<0.01$) better survival rate of 84% compared with other indications for revision, which provides further evidence that this indication is a positive predictor of survival. Other

significant influences on survival were age greater than 70 at the time of revision and the type of procedure performed.

Analysis of the effect of patient age also showed that survival in those under 60 was 74% in comparison to those over 60, whose survival was 85%. An age greater than 70 has been previously shown to predict outcome [10], but with the patient age of primary THR reducing it can be expected that the age at which revision occurs will also reduce. A 10-year survival of 74% is comparable with other 10-year outcomes [8] but given the difference between the two groups it would suggest that revision in those under 60 should if possible be delayed, particularly when the survival in those under 70 years rises to 79%.

Our study has shown at 10 years that the only positive predictor of functional outcome was a revision of both components. Previously, short-term follow-up has demonstrated that age, gender and operative indication have a predictive outcome on revision THR [12,13]. Our longer-term study with greater numbers did not show a significant link, although there was a trend for a better outcome in young, male patients who had a single stage procedure. Although different functional outcome measures were used in this study when compared to others, the OHS has previously been shown to be a valid patient based outcome measure for revision THR [20].

Of note is that, although not significant, patients revised for unexplained pain had better satisfaction post-operatively than any other group. By contrast, the same group had the lowest survival (58% 95% CI: 32-83), which was statistically significant. This discrepancy between satisfaction rates and implant survival is difficult to

explain. Poor survival suggests that hips should not be revised without sufficient cause, a sentiment previously stated by other orthopaedic surgeons [21]. However, those who did not need re-revision, were very pleased with the outcome and the mean OHS was not dissimilar to other groups.

PROMs are increasingly being used to define the success of an operative outcome. However, the correlation between PROMs and patient satisfaction is variable and, although a relatively simple measure, purely reported patient satisfaction could be argued as being a true definition of operative success. It is interesting to note that the OHS correlated strongly with patient satisfaction and was not significantly different between groups of patients revised for specific indications. Yet, there remains a contradiction as in those patient groups that were the most satisfied, the overall survival was poorer than the overall mean and particularly in those revised for unexplained pain. Further research into this contradiction is clearly required.

Post revision surgery the mean OHS was 34 in our study demonstrating the success of primary revision hip surgery in comparison to the initial pathology. However, if one assumes that an OHS less than 20 represents a poor functional outcome, (as it is comparable to the initial pre-primary THR OHS [22]), the survival of revision THR falls to 77% at 10 years. These data are crucial for surgeons when counselling patients who are being listed for a primary revision. A patient can expect approximately a four out of five chance that the revision surgery will not only last for 10 years but will also be better than their original pre-primary status.

Patient satisfaction has previously been reported to reflect outcome [5,23]. Our long-term study on a large cohort of patients confirms that there is a significant ($p < 0.001$) correlation between functional outcome and satisfaction. However, the correlation that existed (corr. coeff. = 0.534) was only fair. This shows the importance of using multiple outcome measures to define operation success rather than relying on a single outcome score and certainly is a weakness of the study.

We recognise the limitations of a retrospective study such as this. It would certainly be beneficial to be able to provide pre-operative assessments to compare our outcomes too, as well as more initial demographic data. Additionally, despite our rigorous attempts to cross check patients, (both alive and deceased), it is possible that deceased patients could have had a further revision at another centre. However, a worst case survival scenario of 79% is still comparable to previously reported outcomes. Furthermore, our large cohort is a very heterogeneous group. However, rather than a weakness we believe it represents a strength as it provides a real picture of primary revision THR in day-to-day clinical practice.

5. Conclusion

In conclusion, this study demonstrates that primary revision hip surgery in those patients over 70 years, for aseptic loosening and with revision of both components provides a positive predictor of survival at 10 years. Additionally, this study shows that in this cohort of patients improved functional outcome measures correlated with younger patients who had a “single-stage” revision and that overall patient satisfaction is high for primary hip revision surgery. Further research is though necessary into predictors of PROMs.

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Conflict of Interest Statement

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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List of Tables

Table 1. Total hip replacement revision 10-year survivorship

Variable		Number of hips	Survivorship (%)	95% CI
Gender	Male	504	83	80-87
	Female	672	82	78-85
Age category	>70 years	556	89	86-92
	<70 years	620	79	75-82
Procedure	Both components	576	84	80-87
	Cup only	306	86	82-90
	Stem only	188	77	70-84
	Two-stage revision	94	76	67-86
	Isolated head/liner exchange	12	60	32-87
Indication	Aseptic loosening	843	84	82-87
	Infection	111	78	69-86
	Instability	64	78	66-90
	Peri-prosthetic fracture	92	73	62-85
	Unexplained pain	19	58	32-83
	Other	47		

Table 2: A table demonstrating the proportion of patients that were satisfied with their revision outcome (numbers in brackets show actual number of patients)

Unsatisfied		Satisfied	
8.2% (41)		91.8% (459)	
Very pleased	Not very pleased	Fairly pleased	Very pleased
4.4% (22)	3.8% (19)	20.8% (104)	71.0% (355)

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Figure 2: A graph demonstrating implant survivorship by procedure

Figure 3: A graph showing implant survivorship by indication for revision

Figure 4: A histogram demonstrating the number of patients with each OHS

Figure 5: A Box-plot showing the OHS by procedure undertaken

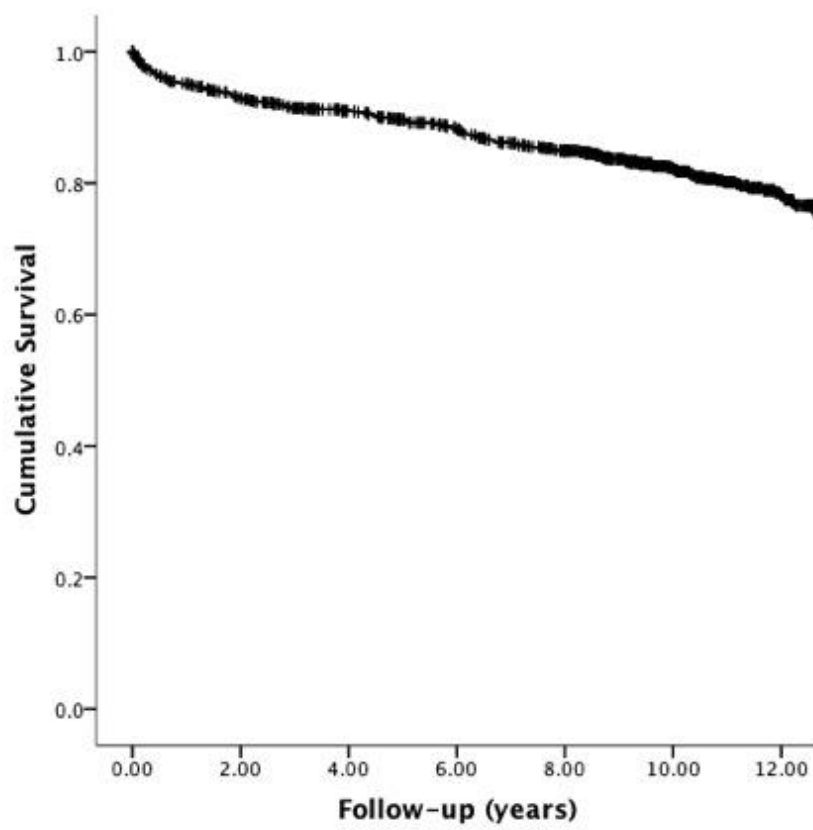


Figure 1

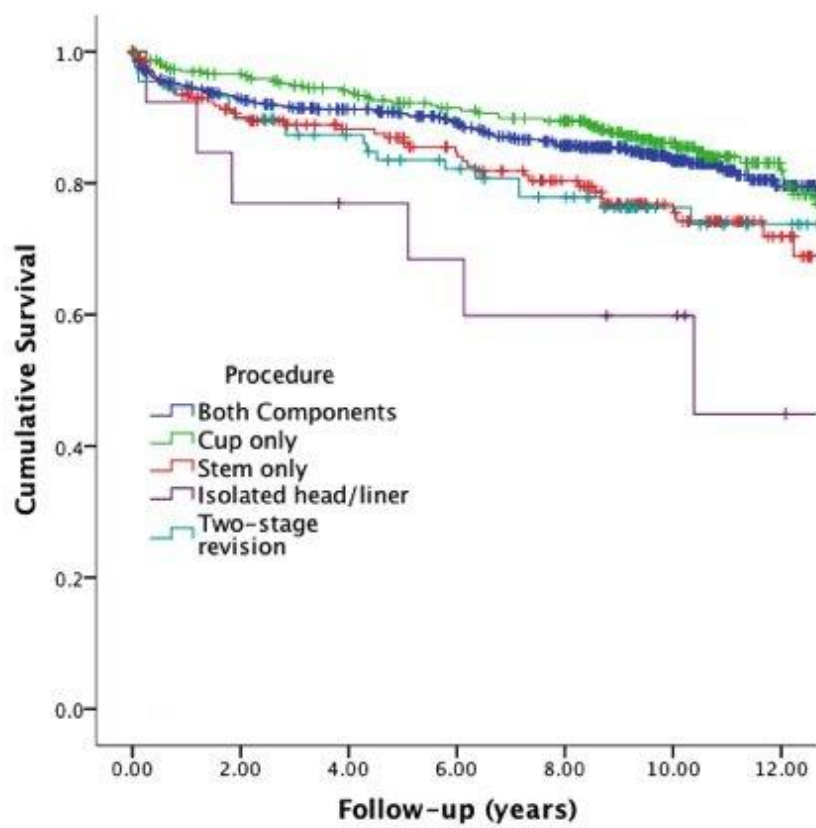


Figure 2

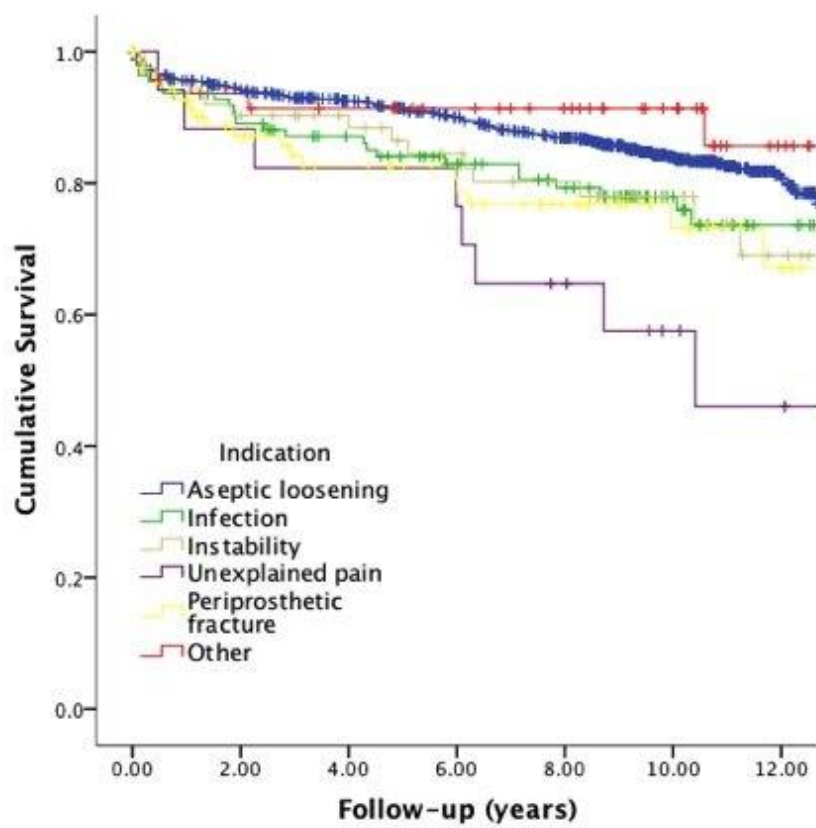


Figure 3

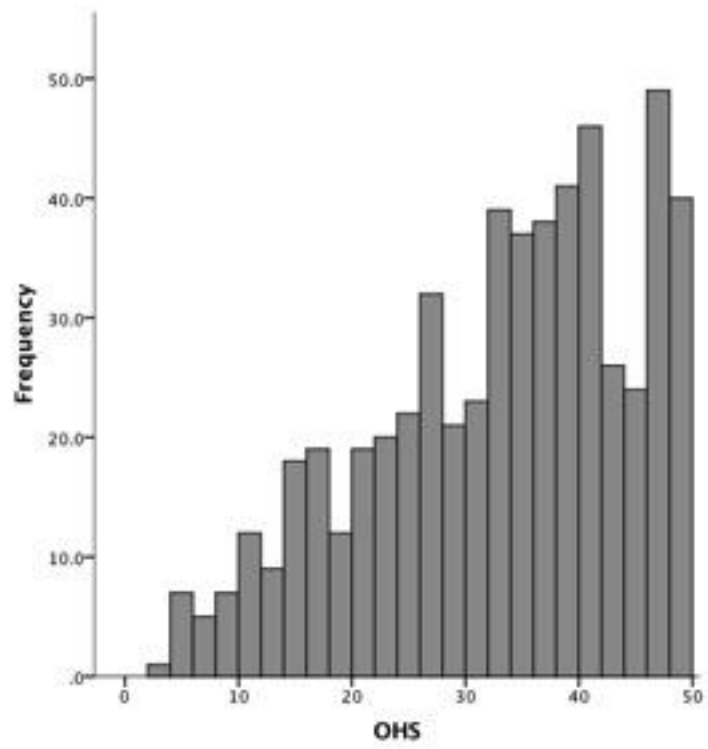


Figure 4

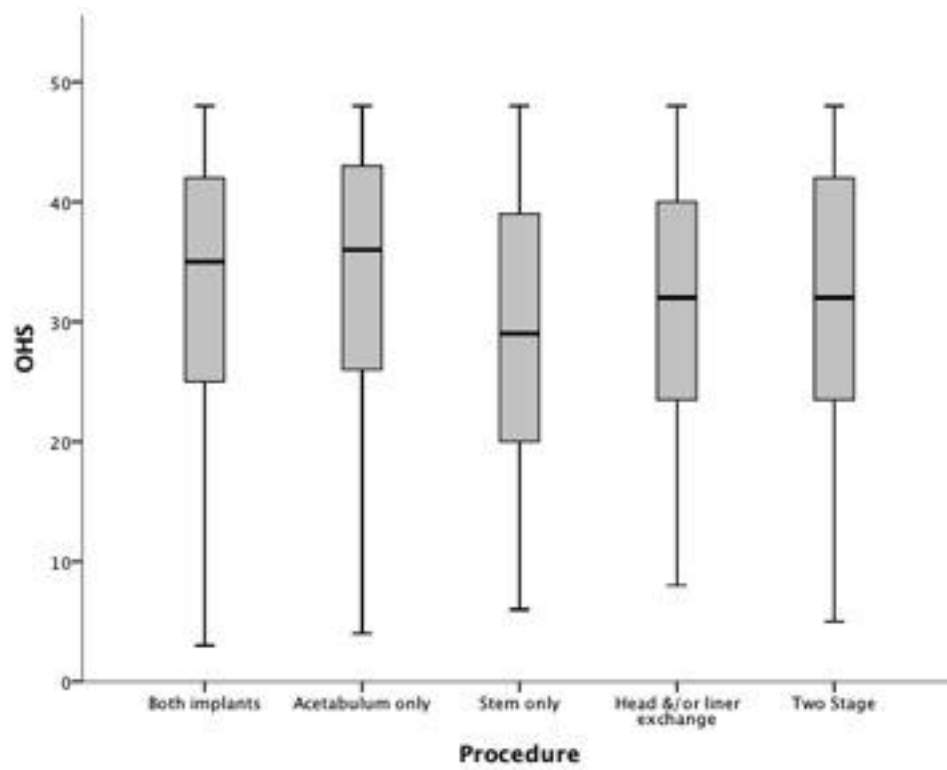


Figure 5